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09/403,220	12/20/1999	RON LEVKOVITZ	154/01214	6991

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WILLIAM H. DIPPert  
REED SMITH LLP  
599 LEXINGTON AVENUE, 29TH FLOOR  
NEW YORK, NY 10022-7650

EXAMINER

DASTOURI, MEHRDAD

ART UNIT	PAPER NUMBER
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2623

DATE MAILED: 10/08/2004

22

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/403,220

Applicant(s)

LEV KOVITZ ET AL.

Examiner

Mehrdad Dastouri

Art Unit

2623

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 02 August 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-35 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-35 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftperson's Patent Drawing Review (PTO-948)                                    | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

## **DETAILED ACTION**

### ***Response to Applicants' Remarks***

1. Applicants' response After Final filed August 2, 2004, has been entered and made of record.
2. Applicant's request for reconsideration of the finality of the rejection of the last Office action has been fully considered. Applicants' arguments concerning rejection of Claims 22-35 are persuasive and, therefore, the finality of that action is withdrawn.

### ***Claim Rejections - 35 USC § 102***

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

4. Claims 1, 6-11, 13, 14 and 18 are rejected under 35 U.S.C. 102(b) as being anticipated by Hudson et al., (hereinafter Hudson), (Accelerated Image Reconstruction using Ordered Subsets of Projection Data).

As per Claim 1, Hudson teaches:

acquiring data on the geometric coordinates of detection of individual radiation events (Pages 601/602, Section II. Individual radiation events are detection of oppositely directed gamma rays, known as "lines of response" or "coincidence lines" which are inherently performed in PET.);

separately distributing a weight of each of the individual radiation events along a line of flight associated with the event determined from the acquired data on the

geometric coordinates of detection of the individual event (Page 602, Weights  $a_{ij}$  associated with pixel  $j$ ); and

Iteratively reconstructing the image based on the distributed weights (Abstract; Pages 601/602, Section II).

As per Claim 6, Hudson teaches:

wherein iteratively reconstruction the image comprises applying an iterative expectation maximization (EM) method on the data in sub-sets (Abstract).

As per Claim 7, Hudson teaches: wherein the individual events form the separate subsets (Page 601, Section II).

As per claim 8, Hudson teaches: wherein the sub-sets are formed based on the time of acquisition of events (Pages 601-602, Section II).

As per claim 9, Hudson teaches:

wherein the sub-sets are formed from unrelated events (Pages 601-602, Section II).

Regarding Claim 10, arguments analogous to those presented for Claim 1 are applicable to Claim 10.

As per Claim 11, Hudson teaches:

wherein the subsets consist of data having less than a 180 degree view angle (120 degrees, Page 602, Column 2, Sect. III, first paragraph).

As per Claim 13, Hudson teaches: wherein iterations are commenced on receipt of the first detection event (Page 602, Column 1, second paragraph, the initial state is a uniform prespecified starting image).

As per Claim 14, Hudson teaches:

displaying an evolving image based on successive iterations iterative method on a display (Page 603, Column 1, under Cumulative subsets heading). Under the Cumulative subsets heading, Hudson teaches that data is combined to form a current restoration.

As per Claim 18, Hudson teaches: wherein data is reused in subsequent iterations of the EM algorithm (Page 601, Column 2, last full paragraph).

***Claim Rejections - 35 USC § 103***

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

6. Claims 2, 12, 16, 17 and 19-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hasegawa et al., (hereinafter Hasegawa), (U.S. 5,376,795) in view of Hudson et al., (hereinafter Malcolm Hudson), (Accelerated Image Reconstruction using Ordered Subsets of Projection Data).

As per Claim 2, Hasegawa teaches:

wherein the weights are distributed in voxels (Column 10, Line 41) along the line of flight. However, Hasegawa does not specifically teach that such weights are

distributed based on the probability that an event occurred in particular voxels. But Hudson teaches:

is distributed based on the probability that an event occurred in particular voxels. (Page 602, Column 1, in the paragraph continued from Page 601).

Therefore, it would have been obvious to one of ordinary skill in the art to utilize the weighting system of Hudson as an equivalent weighting system in the system of Hasegawa in order to take advantage of the full features of Hudson's ordered subset approach.

As per Claim 12, Hasegawa teaches:

wherein iterations of the EM Method are performed prior to the acquisition of data having a 180 degree angle of view (initial image estimate is prior to any data acquisition having an 180 degree view angle, Column 4, Lines 48-52).

As per Claim 16, Hasegawa teaches:

wherein intermediate images are filtered with a smoothing filter between iterations of the EM method (Column 8, Lines 29-33).

As per Claim 17, Hasegawa teaches:

wherein intermediate images are filtered with a noise reducing filter between iterations of the EM method (Column 8, Lines 29-33).

As per Claim 19, Hasegawa teaches: wherein the images are three dimensional images (Column 6, Lines 23-35, voxels are obviously a 3 dimensional data representation, Column 10, Lines 35-49).

As per Claim 20, Hasegawa teaches: wherein the iterative method comprises reconstructing the events without forming two dimensional data sets (Column 10, Lines

35-49, which teaches voxels, which indicates a three dimensional data set and Column 14, Lines 11-13 to correct "partial-volume effects").

As per Claim 21, Hasegawa teaches: wherein the iterative method comprises reconstructing from the events without forming sinograms for slices of the three dimensional data (slices are not used in the reconstruction of the images, Column 10. Lines 35-49).

7. Claims 3-5 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hudson et al., (hereinafter Malcolm Hudson), (Accelerated Image Reconstruction using Ordered Subsets of Projection Data) in view of Muehllehner et al. (hereinafter Muehllehner), (U.S. 5,531,553).

As per Claim 3, Hudson do not explicitly disclose conventional processing details in PET wherein the line of flight of an event is determined based on the position at which the event was detected on a detector and the acceptance direction of a collimator through which the detector receives radiation associated with the events.

Muehllehner disclose three-dimensional image reconstruction for a positron emission tomography wherein the line of flight of an event is determined based on the position at which the event was detected on a detector and the acceptance direction of a collimator through which the detector receives radiation associated with the events (Column 1, Lines 11-20).

It would have been obvious to one of ordinary skill in the art to modify Hudson invention according to the teachings of and Muehllehner to incorporate further limitation recited in Claim 3, because it is the conventional methodology routinely implemented in tomographic image reconstruction.

As per Claim 4, Muehllehner teaches: Wherein the line of light of an event is determined by the position on a detector on which the event is detected and the location of the source of radiation associated with the event (figures 1A and 1B).

It would have been obvious to one of ordinary skill in the art to modify Hudson invention according to the teachings of and Muehllehner to incorporate further limitation recited in Claim 4, because it is the conventional methodology routinely implemented in tomographic image reconstruction.

As per Claim 5, Muehllehner teaches: wherein the line of flight associated with an event is determined by detection of two coincident photons (Column 2, Lines 8-14).

It would have been obvious to one of ordinary skill in the art to modify Hudson invention according to the teachings of and Muehllehner to incorporate further limitation recited in Claim 5, because it is the conventional methodology routinely implemented in tomographic image reconstruction.

8. Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Hudson as applied to Claim 10 above, and further in view of Reitan (U.S. 5,600,574).

As per claim 15, Hudson does not specifically teach terminating a study. However, Reitan teaches:

determining if a study should be terminated based on the image quality of an image after an iteration (Column 25, Lines 44-49).

It would have been obvious to one of ordinary skill in the art to use the automatic image quality process of Reitan to automatically terminate the image reconstruction process of Hasegawa and Hudson when the image quality does not meet minimum



quality standards thereby, reducing the amount of time and computational cost that may be wasted by reconstructing unusable images.

9. Claims 22-35 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hudson et al., (hereinafter Malcolm Hudson), (Accelerated Image Reconstruction using Ordered Subsets of Projection Data) further in view of Hasegawa et al. (hereinafter Hasegawa), (U.S. 5,376,795) and Shimoni et al., (hereinafter Shimoni), (U.S. 4,570,224).

Regarding Claims 22, 31 and 33, arguments analogous to those presented for Claim 1 are applicable to Claims 22, 31 and 33. Claims 31 and 33 further recite a limitation that the sensors are "spatially continuous area detectors" and "substantially planar area detectors" respectively, which is taught by Hasegawa in Figures IA-1D, elements 12, 13 or 14.

Hudson or Hasegawa does not specifically disclose utilizing unbinned individual events in reconstructing tomographic images.

However, Shimoni discloses reconstructing tomographic images from unbinned individual radiation event (Figure 2, process depicted in Line 26; Column 3, Lines 17-33. Unbinned (unrebinned data or the unbinned original data) are used in the process of image reconstruction.).

It would have been obvious to one of ordinary skill in the art to modify Hudson and/or Hasegawa combination in accordance with the teachings of Shimoni to use unbinned data in reconstruction of three-dimensional tomographic images because it will cancel out the artifacts normally caused by the unequal lateral spacing (Shimoni, Column 3, Lines 17-21).

Claims 23-30, 32, 34 and 35 which are dependent on Claims 22, 31 and 33, recite the same limitations as those of Claims 2-19. Accordingly, regarding Claims 23-30, 32, 34 and 35, arguments analogous to those presented for Claims 2-19 are applicable to Claims 23-30, 32, 34 and 35. Prior arts teachings concerning rejection of these claims are further disclosed as follows:

As per Claim 23, Hasegawa teaches:

wherein reconstructing the image comprises utilizing an expectation maximization (EM) method acting on individual unbinned events (Column 4, Lines 25-38).

As per Claim 24, Hasegawa teaches:

wherein the radiation events are nuclear emission events (Column 1, Lines 40-50, Column 2, Lines 11-13, Column 8, Lines 7-10) and the images are emission tomography images (Column 8, Lines 4-8, Column 9, Lines 8-25).

As per Claim 25, Hasegawa teaches:

wherein the radiation events are positron decay events (Column 1, Lines 60-63 or Hudson, Page 602, Column 2, section III, second paragraph) and wherein the images are PET images (Column 4, Lines 45-46, Column 5, Lines 43-45, Column 8, Lines 7-10, Column 9, Lines 4-12 or Hudson, Page 602, Column 2, section III, second paragraph).

As per claim 26, Hasegawa teaches: Wherein the radiation events are represented by photons which have passed through a subject (Column 9, Lines 8-12) and wherein the images are transmission (Column 6, Lines 3-8).

As per claim 27, Hasegawa teaches: wherein the radiation events are nuclear (radionuclide, Column 5, Lines 43-45) disintegrations and wherein the images are nuclear transmission tomographic images (Column 6, Lines 6-8).

As per claim 28, Hasegawa teaches: wherein the radiation events are X-rays (Column 5, Line 44) and wherein the images are X-ray CT images (Column 3, Lines 50-67, Column 4, Lines 5-9, Column 6, Lines 3-8, Column 8, Line 66- Column 9, Line 4).

As per claim 29, Hasegawa teaches: wherein the line of flight associated with the radiation events form a fan beam (clearly from Hasegawa's Figure 2, the line of flight of the photons will be in the form of a fan beam also, Column 7, Lines 28-30).

As per claim 30, Hasegawa teaches: wherein the line of flight associated with the radiation events form a cone beam (Column 7, Lines 28-30).

As per claim 32, Hasegawa teaches: wherein the spatially continuous detectors are substantially planar detectors (Figure 1 A, element 12).

As per claim 34, Hasegawa teaches: wherein the plurality of detectors consists of two such detectors (Figure 1A, element 12, transmission & radionuclide emission detector).

As per claim 35, Hasegawa teaches: wherein the images are three dimensional images (Column 6, Lines 23-35, voxels are obviously 3 dimensional, Column 10, Lines 35-49).

#### ***Contact Information***

10. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mehrdad Dastouri whose telephone number is (703)

305-2438. The examiner can normally be reached on Monday to Friday from 8:00 a.m. to 4:30 p.m..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amelia Au can be reached on (703) 308-6604. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Mehrdad Dastouri  
Primary Examiner  
Group Art Unit 2623  
August 21, 2004

MEHRDAD DASTOURI  
PRIMARY EXAMINER

*Mehrdad Dastouri*